Science and Technology Policy
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Quantitative Analysis of Japan’s Industrial Competitiveness: Innovation Policy Implications for Reforming Japan’s Innovation System

Interviewer: Chiyoko Kanno, Communication Director, Strategic Research Base Promotion Office

—— Would you talk about your research theme?

The ultimate goal of my research is to develop ways to strengthen the competitiveness of Japanese industry, in particular information-technology-related industries. At present, there is a widely held view that Japanese electronics and other major industries appear to be losing their competitive power. But is that really true? It is therefore necessary to analyze and assess the present situation properly. If that is the case, the causes of these problems need to be investigated. From that, I will then proceed to the next step, ie., of finding policy measures to solve the problem. To this end, a wide scope of analysis is needed on various matters, such as our innovation system, including university-industry collaboration, and competition with China and other countries.

—— I understand that, in the first place, you make an accurate assessment of the present situation based on data. As a result, if problems are found, you will seek solutions and eventually come up with relevant policy measures.

When assessing industrial performance, I give greatest attention to an index of productivity. The scale of economic activities can be represented by gross domestic product (GDP). Japan's real economic growth rate at present is said to be around 2%. In the 1980s, the Japanese economy was very strong, growing at a rate of over 4% annually. Then, going into the second half of the 1990s, the pace of growth decelerated considerably, to the 1% range. Such rapid deceleration has led to a very symbolic view - the lowering competitiveness of Japanese industry. Looking at the economic growth rate in detail, on the supply side, with Japan's decreasing population, we need to examine the impact of labor input decreases. There is a capital contribution to economic growth. Furthermore, the rest of economic growth can be explained by Total Factor Productivity (TFP). In addition to labor and capital-related factors, it is important to improve TFP. Particularly, the economic growth rates of advanced countries are influenced by productivity. The results of a detailed analysis in this regard can be found in my recent book, "IT Inobeishon No Jissho Bunseki (An Empirical Analysis of IT Innovation)*1."

What is the origin of productivity? It's innovation. In Japanese, we usually say "gijutsu kakushin," or technological innovation. But innovation takes place not only in technological terms. For instance, the computer company Dell has established a unique supply system that provides its personal computers in a highly productive manner. Another example is the Toyota system. These are examples of organizational innovation, which is different from technological innovation, such as the development of new drugs and new semiconductor chips. Indeed, the real meaning of innovation is to change something, not only technological matters.

“A New Trend: A Network-type Innovation System through active Alliances and Collaboration

——Is the study of productivity part of the research on industrial competitiveness you mentioned earlier?

Discussions about productivity fall into several categories. Innovation comes first as a determining factor for productivity as I mentioned earlier looking at this in detail, there is innovation based on research and development (R&D) being carried out by companies. This is technological nnovation.

A company's R&D activities actually contribute to an improvement in its productivity, which in turn spreads over the industry. My study first focuses on this point. Industries conducting vigorous R&D activities are called high-tech industries. For instance, in the pharmaceutical sector, the ratio of R&D spending to sales reaches nearly 10%, or even exceeds 10% in some companies. The ratio is also high in the electronics industry, at 7% or 8%. A considerable amount of R&D expenses are used in the industry as a whole. Companies in these industries spend R&D expenses to develop new technologies. They are different from sectors that make capital investments to build plants for producing goods.

What is particularly important today when considering relations between innovation and companies' R&D activities is that companies increasingly form networks with outside parties, instead of doing all of such activities in-house. This trend is rapidly growing these days. Traditionally, Japanese companies have engaged in R&D in-house. Large corporations' R&D expenses form a major proportion of overall R&D expenses in Japan. R&D expenses in the private sector in Japan total some JPY12 trillion, of which the combined spending of the top 10 companies in terms of R&D is around JPY4 trillion to JPY 5 trillion. That is to say, nearly half of the R&D expenses in the private sector are spent by the top 10 companies. For example, Toyota spends about JPY700 billion, while Matsushita spends around JPY600 billion or so. In addition to a handful of these large corporations, numerous small companies are also engaged in R&D using smaller budgets. Large companies have their own research laboratories, where they can perform basic research and product development. However, this method is becoming less efficient these days and Japan's innovation system now needs to shift from one where traditional large companies' have an in-house R&D system to a network-type system, where collaborating with universities, other companies, or start-up companies is used. This is one such way of viewing the innovation system. I started attempting an international comparison of this when I was at the "OECD*2" more than 5 years ago. This study has continued up to the present day.

How should we proceed with university-industry collaboration? When companies' R&D activities were completed within their own innovation systems, they did not feel the need to work with universities so much. But in recent years, as shown in a survey report conducted by the Research Institute of Economy, Trade and Industry (RIETI) (2003 Survey on University Industry Collaboration), R&D competition has heated up significantly. In the electronics industry in particular, Japanese manufacturers dominated in the areas of semiconductors, household appliances and liquid crystal display components between the second half of the 1980s and the early 1990s. However, over recent years, competition has grown in these areas from companies in South Korea, Taiwan and China . Japanese companies in the past gained profits in a broad range of areas, but they are now in urgent need of extending to frontier areas of research as their share is diminishing in less advanced technological areas. Naturally, research competition is intensifying and latecomers are catching up with them at a rapid pace. So, the speed of development is important. Furthermore, since the complexity of research has increased in front-end fields, the scope of R&D needs to be extended, not to mention increasing speed. A development system that satisfies such requirements cannot be retained by a single company. This means that companies' research should focus on core areas and other activities should be entrusted to start-up businesses or universities. Collaboration with other companies may be feasible, too. Thus, the form of R&D system will shift to a network-type one.

Another factor is the increasing importance of scientific knowledge when a company makes an R&D investment. One of the most typical areas in this regard is the biotechnology-based pharmaceutical sector. In RCAST, Professor Kodama is engaged in research in this area. For instance, the sequence of human genes has now been decoded completely. Of about 20,000 genes, which genes relate to human diseases? Until recently, drugs had been developed by empirical methods. For example, microbes were taken from a tropical rain forest and they were given to mice. Nowadays, it is becoming possible to determine the root causes of certain diseases. Analysis of the structure of a protein that causes a disease and genome decoding had been a very academic form of basic research. But, as a result of such basic research, the mechanism that causes cancer has gradually been revealed. In consequence, the scope of R&D at pharmaceutical companies has approached that found in university laboratories. If university research produces specific results, pharmaceutical companies can utilize the results to develop products. Thus, university-industry collaboration has advanced remarkably in this field. On the university side, knowing that their basic research can be applied for industrial purposes, researchers have increasingly started venture businesses originating from universities. For pharmaceutical companies, with the importance of scientific knowledge growing during the process of R&D, they started forming alliances with research institutes. This move has begun to be seen not only in the pharmaceutical industry but also in some electronics areas, such as semiconductor miniaturization technology and the development of devices, including liquid crystal and organic electroluminescence (EL) displays, which have been studied extensively in universities.

These two factors have encouraged Japanese companies to adopt a network-type innovation system. As a matter of course, to form a network, a partner is needed. But a systemic problem has existed in Japan, that is, large companies have had self-contained R&D systems. This has discouraged people from launching start-up businesses. Furthermore, the low mobility of human resources has impeded researchers' spinning out of universities. Having no opportunity to exchange researchers between companies and universities, they have had no knowledge of what their counterparts are doing. Due to such circumstances, they cannot conduct university-industry collaboration effectively. In addition to these human resource problems, there have also been financing problems. In Japan, banks have played a major role in financing and they have not supplied money to businesses involving risk. Then, even if venture capital is established and the government has supplied funds, there are no personnel who are capable of making efficient use of such funds. Thus, we need to cope with these problems related to human resources and financial resources, as well as patent matters, in a comprehensive manner to shift to a network-type

environment. However, there are various restrictions in terms of policy.

——To sum up, Japan's innovation system is now in the process of shifting to a network-type system in line with the changing needs of the market, but there are restrictions in policy terms. It will be impossible to form networks leading to innovation unless such restrictions are eliminated. We may be in a period of transition at present. Are you going to study factors that can break through the situation and facilitate change, thereby bringing about innovation in policy terms?

A comparison of university-industry collaboration between large companies and small and medium-sized enterprises shows that the latter have produced relatively successful results. It is certain that larger companies engage in basic, high-level research. Since smaller firms are under severe restrictions in terms of both human and financial resources, they try to make good use of universities' technologies, having clear concepts from the outset. With regard to productivity discussed earlier, the results of a survey show that small and medium-sized enterprises, particularly R&D-type venture businesses and younger companies, have achieved better results from university-industry collaboration. Although large companies are less restricted, they have greater difficulty in accepting technologies from outside as they have their own research units. They have sections handling licenses and if a technology is brought in from outside, internal researchers are not pleased with that. They are told, for instance, that in-house development is less expensive.

At present, discussion is taking place concerning university-industry collaboration policies. Among such discussion, it is possible that a system called a matching fund program will be instituted. Under this program, funds will be supplied to universities and companies on application for the development and dissemination of technologies. If a special quota is set in the program to encourage collaboration between start-up businesses or small and medium-sized enterprises and universities, better results from such collaboration can be expected. It is possible that smaller firms may become engines to promote network-type innovation as they are different from large corporations, which tend to be self-contained. If this happens, that will be beneficial to large companies as well, because more efficient collaboration can be expected with domestic start-up businesses having specialized technologies than with those in Silicon Valley or other countries. There are research results verifying the effects achieved by changing an entire innovation system using econometric models. In fact, I have proposed this approach to the Ministry of Economy, Trade and Industry and the Ministry of Education, Culture, Sports, Science and Technology(MEXT).

Economic System Reform - The Key to the Promotion of University-Industry-Government Collaboration

——Would you tell us about your objective view on the university-industry collaboration underway at RCAST?

My understanding is that RCAST is the place provided to members of the Faculty of Engineering of the University of Tokyo where they can devote themselves for around ten years to their studies, rather than teaching. It would be very meaningful to consider that the center can act as an intermediary between research capacities in the University of Tokyo and that it provides opportunities to promote university-industry collaboration by using the whole of the university's research resources.

I've been here for only about one year, but my impression of RCAST has not changed so much since joining the center. My research on university-industry collaboration places heavier emphasis on companies than universities. So, I want to hear from RCAST members about the actual state of university-industry collaboration within the center as an example of such relations as viewed from the university. If there are any shortcomings, I'd like to come up with remedial measures, including policy proposals.

——Can we expect that RCAST will possibly become a model of university-industry collaboration? Japan today appears to be in a severe situation with regard to industrial competitiveness. If industry-university collaboration advances, the situation will change and we may be able to see a brighter future.

How can we improve GDP? In other words, how can we foster the competitive strength of Japanese companies so that they can gain profits? When dealing with this challenge, science and technology policies are very important in relation to productivity, as I mentioned earlier, but science and technology policies alone are not sufficient. It is increasingly necessary to establish a right direction so as to reform Japan's economic system, innovation system and the institutional structure of the nation's economic system overall.

In fact, science and technology policies are economic policies. For instance, the mobilization of science and technology personnel has been incorporated into the Second Science and Technology Basic Plan. But the plan covers only researchers in universities and national research institutes and it makes no mention of companies. Whether or not we can see a bright future is dependent on upon the innovative activities of companies as a producer of new products. Universities supply upstream knowledge, but they are incapable of producing output. This point must be taken into account when considering the mobilization of human resources.

What problems will arise when the mobilization of human resources takes place among universities, public research organizations and companies? For instance, the issues of pension portability and employment mobilization will arise. What is needed here is economic policy. As for financing matters, changing the country's major financing method from direct financing to indirect financing should eventually facilitate the launch of start-up businesses. Indeed, this is closely related to what type of economic system Japan should adopt.

——Do you mean that science and technology policies do not work well unless basic matters in society are managed effectively as a whole?

I often use "innovation," rather than "science and technology." Innovation covers all the processes up to product

development, which leads to the production of practical products. Even if you make a great invention, you can't make money if a product is not produced. Naturally, what is expected of universities is not moneymaking alone. Rather, they are expected to open up an academic frontier and contribute internationally by spreading knowledge to various parts of the world, where knowledge spillover will take place. Academia should make an academic contribution, rather than just pursuing profit. That's right. But when contemplating Japan's bright future, what kind of role should universities play? At present, there is apprehension that Japan's industrial competitiveness is falling and it might even be possible that Japanese industries will be defeated by Chinese counterparts sometime in the future. To respond to such an immediate problem, I will continue to think about ways to strengthen Japan's industrial competitiveness and universities' position in that context.

Let us return to the question of whether we can expect a bright future for Japan. My own view is that we do not need to be over pessimistic about our future at all. Currently, I am engaged in research on China. To examine that country's potential, I have analyzed various science and technology-related data. So far, there is a considerable disparity between leading companies in China and their Japanese counterparts. However, considering China's very big market, an important point is what strategy we should use to capture the market. A challenge for Japan is related to the open-type innovation system. Japan's population is about 100 million, while China has a population of over 1 billion. Japan's economic growth rate is only about 2% to 3% and its population is dropping, while the Chinese market grows by 7% to 8% every year. Thus, China has vast growth potential and the size of its market on the whole is far larger than that of Japan. In order to win over such an enormous market, it is essential to establish good relations with Chinese companies. In Japan, with the population decreasing and the number of children falling, universities should face difficult conditions from now on. Thus, we need to map out our future from a strategic viewpoint, including how to mobilize excellent human resources from China.

——To that end, should we establish a system to attract excellent human resources to Japan?

Regrettably, promising persons who are expected to lead science and technology in the future at the front end tend to go to the United States. Will Japanese companies be able to take the leadership in the world in the true sense of the word in the future? Japanese companies almost entirely dominate in the consumer electronics sector at present, but manufacturers in South Korea and other countries are on their heels. Unique IT-related firms are, for the most part, American companies. The competitiveness of Japanese companies overall is lower than that of their American counterparts. Should they cooperate with companies in China and other countries to have an edge over American rivals? This is an urgent problem for Japan.

Observing Changes in the Innovation Process using Patent Databases

——Would you talk about your plan for the period ahead?

As a science student by origin, since I entered METI I have striven to think over matters in a scientific manner. We may have a vague impression about various things. For instance, China is terrific; public investment should be made in the information sector; and so forth. However, when allocating national resources, figures must be given in the end. To calculate figures, in the first place, we need to analyze the present condition using data. When the parameter changes, how will the results change? For instance, if ¥100 billion is spent for university-industry collaboration, how much economic effect will it bring about? When talking about ¥20 trillion to ¥30 trillion spending for science and technology, discussion from an objective viewpoint on the basis of figures is essential. I have consciously adopted such a way of thinking since I entered the Ministry. As a first step, I objectively analyze the present situation on the basis of figures. Then, I come up with a specific policy in a quantitative manner. That is the method I have followed.

It is becoming very important to handle micro data, or data on individual companies and patents. This is a rather new topic being discussed among researchers. If there is a policy, the policy may not be beneficial to all people. For instance, if small and medium-sized enterprises are to be treated favorably, the allocation of resources to larger companies must be reduced because national resources are limited. This policy may not please all companies. Companies are different by their type of business and size. There are well-established companies, while there are also start-up businesses. There are companies' whose management is planning an international business strategy, while others are operating only domestically. Indeed, there are all kinds of companies. Therefore, we need data at the company level when analyzing the present state of distribution and when considering what type of companies should be targeted. Furthermore, such data is needed when comparing policy options to determine what will be most effective for Japan and what can be adopted as policy.

Needless to say, policy can focus on a specific target area. Therefore, assessment of the present situation on an industry-by-industry basis is not adequate. For instance, it is insufficient to say that R&D expenses spent in the electrical machinery industry totals ¥3 trillion. Instead, we should analyze more detailed information. For example, the number of companies engaged in electrical machinery-related business; kinds of operations they are engaged in; and the number o f companies engaged in each kind of operation. Then, a policy should be formulated based on micro data, or company-level data, taking into account the situation of the specific area at which the policy aims..

When making an analysis using such company-level micro data, we need to handle a massive amount of data. Looking at Japanese patent data, for instance, Matsushita applies for over 10,000 patents every year. The company alone has some 100,000 patents. Since Japanese patent data is extremely detailed micro data, which embodies the results of technologies, they can be used for various research. I am currently working together with Professor Akira Goto of RCAST and other researchers to construct a database of all the patents

filed in Japan in and after the 1960s (about 9 million patents). Using this patent database, I plan to carry out research on changes in the innovation process in Japan. Also, we bought Chinese patent data and the construction of a Chinese patent database is in progress. All patent information is published one and a half years after applications are received. Thus, the question is whether the database of patent data can be constructed. All U.S. patent data have been compiled as a database and they are published on the website of the U.S. Patent and Trademark Office so this data is easily accessible to researchers. The European Patent Office (EPO) also offers similar services. Various kinds of analysis will be possible by collecting American, European, Japanese and Chinese data into one database, including the international comparison of competitiveness. I am so eager to release the results of my research in the future.

Links

RCAST
http://www.rcast.u-tokyo.ac.jp

Kazuyuki Motohashi Web Site
http://www.mo.rcast.u-tokyo.ac.jp/index-eng.html

*1:IT Inobeishon No Jissho Bunseki (An Empirical Analysis of IT Innovation):
http://www.rieti.go.jp/en/publications/archives/06.html
=IT Inobeishon No Jissho Bunseki

*2:OECD:
http://www.oecdtokyo.org/tokyo-lan/oecdtokyo-en.html
=OECD